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Compensating the Sailor of the Future

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The objective of this study is to estimate the earnings differentials the Navy might expect to pay for the future sailor. We begin by examining background information on the relationship of skills to earnings and then estimate earnings differentials in the civilian labor market for general skills the Navy will require (compared with the skills the Navy requires now) and for selected new occupations that will come with new technology. We end with a discussion on the impact of the earnings premiums on Navy ship costs and the Navy compensation systems.

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Summary

Background

In the next 30 years, the Navy will introduce several new platforms incorporating new technologies that will change the nature of work on ships. The Navy expects new occupations to emerge, requiring broad-based technical skills and higher levels of education. The need for sailors with these skills poses significant challenges for the Navy. Not only must the Navy determine the specific manpower requirements for the platforms, it must reconsider many manpower issues, such as how to recruit and retain the right sailors, the impact on manpower systems and manpower ship costs, and training and quality of life. Underlying many of these manpower issues are the size and structure of compensation that the new high-tech sailor will receive.

Objectives

Because compensation affects so many other manpower issues, the Navy is concerned with quantifying the costs of the new high-tech sailors. The objective of this study is to estimate the earnings differentials the Navy might expect to pay for the future sailor. We begin by examining background information on the relationship of skills to earnings. We then estimate earnings differentials in the civilian labor market for the general skills the Navy will require (compared with the skills the Navy requires now) and for selected new occupations. Because the Navy will compete with the private sector for recruits, we assume that the Navy will have to offer similar differentials. Using this methodology, we avoid problems with lack of complete and reliable information on benefits and total compensation, and with the noncomparability of earnings between the civilian sector and the military due to differences in their mix of pay and benefits. We end with a

discussion on the impact of the earnings premiums on Navy ship costs and the Navy compensation systems.

Findings

Our review of existing literature suggests that premiums are associated with the higher educational attainment and technical skills the Navy will require. Our findings confirm that suggestion: The greater the disparity between the existing Navy occcupations and future Navy occupations in formal training and required skills, the higher the earnings premium. Based on our general skills analysis, the Navy should expect to pay from 10 to 25 percent more depending on the technical skills and educational requirements of the job.

The earnings premiums we estimate the Navy will have to pay in selected new occupations range from 13 to 34 percent, depending on the jobs being replaced and the supply and demand for specific skills. These premiums are consistent with our general skills estimates, although private sector demand for specific skills and occupations causes some premiums to be higher than the general skills estimates.

Implications and recommendations

The large earnings premiums for future high-tech jobs may have a significant impact on ship costs and on the compensation system. We consider how the premiums will affect both manpower issues.

First, we analyze ship manpower costs. With future platforms in initial design phases, the skill mix of sailors is uncertain and estimating total manpower costs is difficult. Currently, platform program managers generally use average sailor costs. We incorporate into the analysis the higher per-sailor costs. We find that, if Navy manning reduction goals can be realized, the cost decreases from lower manning far outweigh the increased costs per sailor. That said, the occupational premiums could cost the Navy, across platforms, millions more annually than is currently planned. We recommend that the higher manpower costs become embedded in program cost analyses and budgeting. Such action should protect the programs from unexpected shortfalls in funding.

Second, we consider whether the current compensation system can accommodate the higher pay and greater variation in pay. Specifically, we ask whether the Navy will be able to match private sector compensation packages using existing rating-specific bonuses. We conclude that, although existing bonuses may theoretically be large enough, in practice the higher levels of pay and the greater variation in earnings across occupations are significantly outside the Navy's experience. Indeed, the difference in pay between the highest and lowest paid ratings could double. This would obviously stress current compensation systems. Furthermore, by relying on bonuses instead of salaried pay, the current system may not produce the preferred compensation package. The result could have an adverse effect on recruiting and retention.

We recommend that the Navy seek alternatives to the current compensation system. The question of whether the system can be altered to respond more efficiently or should be replaced by a new pay system entirely deserves careful analyses. Within a skill-based pay system, for example, a sailor could remain in a skill level for an entire career and progress to higher paygrades within the skill level, or move to higher skill levels and pay. Tailored in this way, it would allow pay to reflect market conditions and productivity and would provide incentives to attract and retain recruits.

Finally, we suggest that the Navy monitor private-sector earnings for the relevant occupations on a periodic basis, to be able to adjust its plans as economic conditions change.

Introduction

Background

During the next 30 years, the Navy will introduce several new platforms. New technologies on the future platforms will automate many routine tasks and information processing functions that sailors currently perform. In addition, ship maintenance will diminish, and the ships' systems will more closely resemble private-sector counterparts with the use of commercial-off-the-shelf (COTS) technologies. These changes will transform the nature of work that sailors perform at sea and alter the size and skill base of the Navy's enlisted force.

How will sailors' jobs change? Of course, we will not know the full extent of automation on manpower requirements until ships' designs are complete. Certain changes do appear likely, however, based on Navy documents and a series of interviews with program managers, engineers, and others.[1]

It seems clear that some sailors will be displaced by automation, but the new technologies cannot displace everyone, and some jobs—from physical laborer to skilled repairer—may never be fully automated. Thus, some sailors of the future may largely resemble their counterparts of today. Others will find that the automation of workload results in very different jobs requiring very different skills. A new category of enlisted sailor will emerge—the decision-maker versus the traditional operator/repairer. These sailors will be responsible for synthesizing the information provided by the ship's systems. They will assess data, verify the systems' functionality, and make strategic and systems decisions and adjustments. Communicating technical problems and solutions becomes integral to accomplishing the sailors' functions.

1. See [1] for a more complete discussion of future requirements.

What skills and education will these sailors need to perform their jobs? We expect these new sailors will need broad-based knowledge of highly technical fields of study to solve problems. Some will need expertise in general engineering principles, while others will need to know information technology, acoustics, or physics. Because the required knowledge base is driven not by understanding the idiosyncrasies of individual pieces of equipment but by general principles in a field of study, these sailors may be able to receive the technical skills they need through postsecondary education—probably a 2-year Associate degree. Increased computer proficiency and strong communication skills will also be required. Given that the current Navy concentrates on training sailors to be operators and repairers for individual pieces of equipment, the background, skills, and tasking of this new sailor look markedly different.[2]

The need for this new high-tech sailor poses significant challenges for the Navy. Defining the specific requirements of the new platforms is just one facet the Navy must address. Because these sailors will be different from the current sailors, many manpower issues warrant attention. Three areas of critical importance are:

- Whether the Navy can recruit and retain people with the necessary skills
- How the changing skill mix will affect ships' manpower and life-cycle costs
- Whether the Navy's compensation system can meet the needs of the new Navy.

Central to these issues are the size and structure of the compensation package the new high-tech sailor will require.

2. For example, an Electronics Technician (ET) is highly technical now, yet does not receive the in-depth theoretical framework in electronics that someone with an Associate degree would have.

How does the compensation of the new high-tech sailor affect recruiting and retention efforts?

We know that, when individuals make enlistment and retention decisions, monetary incentives and private sector opportunities help motivate their decisions. As military compensation increases or private-sector opportunities decline, more potential recruits enlist. For example, one study for the Army [2] found that a signing bonus of an additional $3,000, or about 25 percent of annual earnings for a newly trained recruit, elicits a 5-percent increase in recruits. The same relations hold true for reenlistment decisions. Reference [3] shows that increasing Selective Reenlistment Bonuses (SRBs) by one level would increase first-term retention by 1.5 percentage points. These bonuses effectively improve the pay in the Navy relative to the private sector—making the Navy a more attractive option.

Because pay affects enlistment and retention choices, the Navy must know how much it would need to pay high-tech sailors to be competitive with the private-sector compensation. If people with high-tech skills require higher compensation than today's sailors but the Navy sets compensation similar to that of today's sailors, recruiting and retaining high-quality people would be very difficult. Knowing the private-sector earnings and compensating the sailor appropriately will be crucial to achieving the Navy's enlistment and retention goals.

How will the required compensation of the new high-tech sailor affect the ship's manpower costs and life-cycle costs?

Currently, over 30 percent of the life-cycle operating costs of a ship may go toward manpower costs. New platforms are tasked with reducing the manpower costs by 20 percent or more depending on the platform, and program managers are seeking to meet their goals by reducing crew size. While cost estimates reflect the smaller crew, they generally have not included changes in the per-sailor compensation cost. The potential for underestimating yearly manpower and total ship costs in the planning and budgeting is of concern to the Navy. Realistically quantifying the manpower costs is crucial to the planning process.

How will the compensation of the new high-tech sailor affect the manpower compensation systems?

The existing manpower systems may suit the Navy's needs well into the future. However, policy and legislation constrain the compensation system. For example, advancement rules by the Navy's Bureau of Personnel mandate how long sailors must be in a given paygrade or in the Navy before being eligible for promotion, while special pays targeting individual ratings, such as SRBs and EBs, are limited by federal law. These constraints limit pay in a given rating and variation in pay across ratings. If the compensation the high-tech sailor needs is higher than is currently in the Navy, the Navy may not be able to offer a compensation package competitive with the private sector.

Even if a competitive compensation package appears feasible, the Navy must determine whether the current systems can accommodate larger pay variations for skill differences. The current systems do allow for some variation in compensation, but variation between ratings is relatively low. For example, average basic pay (which accounts for about two-thirds of total direct compensation) varies little between ratings. Sailors in the lowest paying ratings (SH) earn, on average, about $17,500 annually, while sailors in the highest paying ratings earn about $19,750, or $2,250 more per year.[3] Discretionary pays (SRB and EB) make up most of the funds the Navy may target toward individual ratings. Currently, however, only five ratings have those special proficiency pays averaging more than $2,000 per sailor annually, and none offers over $3,000.

A first step in determining whether the current compensation systems will suit the Navy's needs is to estimate the compensation of the new sailors.

3. These calculations are based on 1996 Joint Uniform Military Pay System (JUMPS) data and exclude sailors with less than 1 year of service in the Navy. This also excludes Gendets and ratings achievable only through promotion.

Objectives

Because of the impact the new high-tech sailors' compensation will have on other manpower issues, the Navy has asked CNA to quantify the additional costs, if any, of these technically skilled sailors and to explore the implications of any cost differentials. We estimate the compensation changes the Navy might expect by analyzing earnings differences for workers with different skill levels and also by comparing earnings for specific new Navy occupations with existing occupations. Because information on differences in benefits is neither complete nor reliable, we focus on earnings differences.

We first examine broad compensation differences between people with differing levels of education and technical skill. We provide background information on the relationship of skills and earnings, and we quantify, using multivariate regressions, the relationship of education/technical skill and earnings. These estimates should provide the Navy general guidance to compensation changes.

Second, we examine several specific new Navy occupations. We select occupations that represent a variety of platforms and replace a wide range of existing skills. We provide background on the tasks involved and the skills required for each job. Then, we quantify the compensation differentials for the new occupations—comparing new occupations with ones being replaced. This analysis gives the Navy more concrete estimates for some changing occupations, while validating the compensation estimates from the general skills analysis. In addition, it highlights the importance of demand for, and supply of, specific occupational skills in determining compensation.

We rely on private sector data for both the broad-compensation and occupational estimations. We anticipate that, for the Navy to compete with private employers for recruits, the Navy will have to pay similar differentials to attract and retain quality recruits. We make these civilian-to-civilian comparisons because differences in the pay and benefit mixes between the civilian and military sector make it difficult to compare earnings packages in a meaningful way.

Once we make these comparisons, we analyze the implications for the Navy. We first look at the manpower costs for specific platforms. Then,

we examine whether existing compensation tools can keep the compensation of sailors in these new occupations competitive with the private sector. We end with a brief discussion of challenges that the current compensation system will face and our recommendations.

Returns to education and technical skills

Our objective in this section is to estimate compensation differences for the Navy as educational and technical skill requirements change. To do this, we first review research on the relationships of earnings, educational attainment, and techology in the private sector. Then, we estimate the differences in compensation between workers in the private sector with various levels of skills, accounting for differences in the characteristics of the workers. Because we anticipate the future occupations to require broad theoretical knowledge of technical fields, we focus our discussion on the earnings for workers with 2-year postsecondary degrees and technical skills.

Literature on returns to education and technical skills

In this section, we summarize the most relevant studies from the economic literature on the impact of both postsecondary education and technology on earnings. We find that the research overwhelmingly supports the notion that people with more education earn higher wages. Economic theory suggests that education raises productivity directly or acts as a signal for people with higher productivity. In either case, higher educational attainment should result in higher wages. In study after study, comparing Bachelor's degrees to high school diplomas, this relationship holds [4].

Although the relationship between Associate degrees and earnings has been less clear, more recent research by Grubb [5] and Kane and Rouse [6] does show positive returns to community-college education. Kane and Rouse find that attendance at a 2-year college (without even finishing the degree) increases earnings about 10 percent above those without any college education. Grubb also finds returns for community college attendance and degrees, but the returns for vocational degrees (including math, science, health care, child care, and other degrees) are higher than for academic degrees (business and general degrees).

The relationship between use of technical skills on the job and earnings is indirect. Some researchers have found that the adoption of technology increases average pay at a firm.[4] Others show that skill levels are higher at firms adopting new technology [8, 9, 10]. Combining the results, we expect that higher skill levels, probably technical skills, are driving the earnings results.

Researchers have studied the effect on earnings of only one component of technical skills—the worker's use of computer technology in an occupation. References [11, 12] show that use of technology and earnings are positively correlated.

Overall, existing research suggests that the Navy will have to pay more for the sailors they will require.

Estimation of the skills-earnings relationship

How do we determine how much more the Navy will have to pay for these new technically skilled sailors? We compare the earnings of similarly trained private-sector workers with the earnings of high school graduates, taking into account differences between the populations.[5] We focus on the earnings differences of workers in the private sector because the Navy will be competing against private-sector employers for recruits.[6] Navy compensation must also reflect those differentials to attract recruits.

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4. Reference [7] provides a useful survey of the literature.

5. Underlying this is the assumption that the Navy will recruit fully trained workers. If the Navy chooses to train recruits, it may still need to pay the higher earnings to be competitive with the private sector. The Navy would also incur the recruits' training costs. For a discussion on recruiting pretrained people, see [1].

6. We do not compare Navy and private-sector earnings directly. Such comparisons are problematic. For example, lower pay in the Navy does not mean that the Navy may not be competitive with the private sector. Instead, the Navy's pay combined with its (more generous) benefits, may result in a total compensation package equal to that in the private sector.

Statistical methodology

To isolate the earnings differences attributed to skill differences alone, we need to control for all quantifiable differences between workers that affect earnings. The use of multivariate regression analyses allows us to capture the effect of education and technical skills on earnings separately, controlling for other factors that may affect earnings. We include in the model explanatory variables to control for differences between workers' work experience, cost of living, and type of employer.

Other factors that we cannot control for, such as a person's motivation or ability, may also be correlated with skill attainment and earnings. For example, people who are more able will find schooling easier than others and will be more likely to enroll in postsecondary studies. But these workers are also more likely to earn more because of their innate abilities. To the extent that we do not control for such factors that positively affect skill attainment and earnings in the regressions, the earnings premiums attributable solely to education and technical skill are overstated. Our purpose, however, is to provide the Navy with guidance regarding pay. Our estimated premiums still reflect the additional amount the Navy will have to pay, but, for that extra pay, the Navy not only gets sailors with more formal skills but gets more able sailors.

Data

The data come from the U.S. Department of Labor's Current Population Survey (CPS). It is the largest and most comprehensive nationally representative survey for employment information. The survey contains information on individuals' earnings and other employment history, as well as demographic and geographic information, skill attainment, and household composition and earnings.

So that we obtain current estimates of earnings differentials that are less sensitive to fluctuations from any one year, we pooled data from the March 1995 and March 1997 surveys for our sample. Because of the CPS's sampling techniques, the sample would contain multiple observations of individual workers if we also included the March 1996 data. To avoid double-counting, we did not use 1996 data.

We selected for our analysis all full-time, nonagricultural workers between the ages of 21 and 40. This sample is more representative of the Navy than the entire sample. From this base sample, we made two additional exclusions. We eliminated workers with graduate degrees because we anticipate little need for such people within the enlisted ranks of the Navy. We also excluded people with full-time yearly earnings that were implausibly low or high.[7] Finally, factors that influence earnings may be very different between demographic groups. Therefore, we separated the sample into three mutually exclusive groups (listed here along with the number of each in our analysis):

- Caucasian men—17,076
- All women—12,895
- Minority men—2,486.

Because white men make up the majority of the enlisted force, we present summary statistics and detailed regression results for this population alone in the main text. We present the summary statistics and results for the other samples in appendix A.

Measuring compensation

Ideally, we would like to compare the value of the entire compensation package—including such things as retirement accruals and health insurance benefits. However, very little information exists on the value of those benefits for each person, so we confine our analyses to monetary compensation.

We focus on workers' annual earnings. Although it does not reflect many benefits, such as health care and retirement benefits, it does reflect their hourly wages and the value of vacation and sick time. In addition, this compensation measure should be somewhat comparable to the combination of the sailor's basic pay and other special pays,

7. For example, we excluded people with earnings substantially under the minimum wage.

excluding those paid to compensate for the particular hardships of military or Navy service.[8]

Educational attainment

Because we expect the Navy to require relatively more sailors with 2-year postsecondary degrees (or the equivalent in training) in the future, we are particularly interested in estimating the returns for Associate degrees. The CPS data include information on the highest level of education attained. We separate people into five mutually exclusive groups (listed along with the number of workers in each category in our primary sample):

- High school dropouts—2,097
- High school graduates—6,814
- Some college—3,499
- Associate degrees—1,605
- Bachelor's degrees—3,061.

We separate those with some college from workers with Associate degrees because the two groups probably do not have the same skills. We suspect that many may classify the receipt of vocational certificates (which may entail very short courses) as "some college." We expect the returns to these classes to differ from the return to 2-year degrees, so this separation is appropriate. In addition, some college reflects people who do not complete a degree. Thus, they may differ from those with degrees in less tangible ways, such as motivation, which is another reason for the separation.

Although we expect Navy requirements to focus on 2-year degrees, the requirements will be driven by the technologies adopted. Because of the uncertainty surrounding the final platform designs and manpower requirements, we have not excluded the possibility of the Navy

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8. Again, because the mix of benefits and pay in the Navy differs from that in the private sector, the civilian annual earnings and Navy pays should not be compared directly. We do not have sufficient information to estimate how Navy hardship pays and benefits would have to change, if at all. Therefore, we focus on regular compensation.

needing workers with even more education for some occupations. For that reason, we include workers with Bachelor's degrees in our compensation analysis.

Technical skill

We also separate private-sector workers into the following two categories (shown here along with the number of workers in each category in our primary sample):

- Nontechnical workers (base for comparison)—13,192
- Technical workers—3,884.

We use the person's occupation to infer the use of technical skills, identifying occupations as being either technical or nontechnical. Although there might be some debate about which occupations are technical, we broadly define technical occupations as those that require an understanding of complex man-made systems. This definition encompasses occupations specifically classified as technicians in the CPS, such as Electrical and Electronics Engineering Technicians, but it also includes other skilled technology-driven occupations, such as Nuclear Medical Technician. Not all of these occupations will correspond directly to the new jobs the Navy will require, but many of the skills within the occupations may be comparable. For example, the job of Nuclear-Power Plant Technician may require sophisticated interpretation of numerical results from complex nuclear systems comparable to that which a Nuclear Engineer would employ.

This division of technical/nontechnical workers does have its shortcomings. Some occupations are not clearly technical or nontechnical, and some people will be misclassified. The effect of the misclassification could be either to understate or to overstate the earnings differentials between technical and nontechnical workers. Based on sensitivity tests in which we changed the occupational classification of 10 percent or more of the sample, we found that the results are not highly sensitive to such changes.

We provide a list of technical occupations in table 1. This list is consistent with previous CNA work [13].

Table 1. Occupations classified as technical by CPS code

Technical occupation	CPS code
Engineers	044-059
Computer Scientists	064-065
Health Technologists and Technicians	203-208
Engineering and Science Technicians	213-225
Technicians, Except Health, Engineering, and Science	226-235
Supervisors, Computer or Communications Operators	304, 306
Computer Equipment Operators	308-309
Dental Assistants	445
Supervisors, Mechanics and Repairers	503
Vehicle and Mobile Equipment Mechanics and Repairers	505-517
Electrical and Electronic Equipment Repairers	523-533
Miscellaneous Mechanics and Repairers	535-549
Electricians	575-577
Tool and Die Makers and Apprentices	634-635
Pattern Makers	645
Plant and System Operators	694-696

In figure 1, we compare the educational attainment of workers within technical occupations to other workers. We see that technical skills are positively correlated with education: 62 percent of the technical workers have some postsecondary schooling and 40 percent have earned postsecondary degrees. This compares to 45 percent and 24 percent in the nontechnical occupations, respectively.

Other factors influencing earnings

To obtain the earnings differences due to education or technical skills alone, it is important to control for other factors that might influence earnings—particularly those that would also be correlated with education or technical skills. For that reason, we control for differences in skills obtained through work experience, as proxied by the age of the worker. Other variables we include in the analysis are the region of the country the worker lives in (to account for regional variations in wages and cost of living) and whether the worker is employed by the government. Table 2 shows the summary statistics for the primary sample.

Figure 1. Educational attainment for technical and nontechnical workers

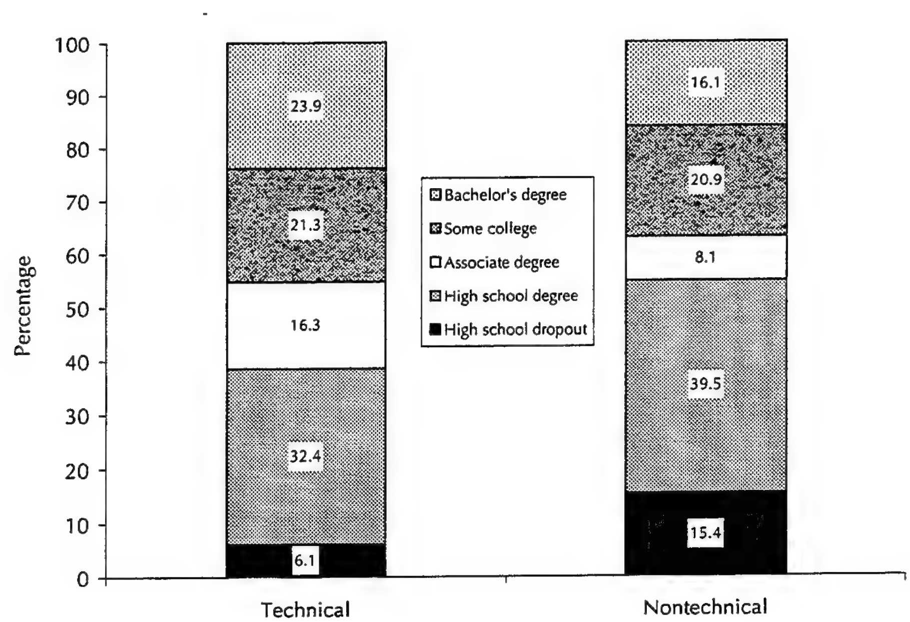


Table 2. Summary statistics for primary sample

Variable	Mean
Outcome	
Annual earnings	30,468
Primary independent variables	
High school dropout	0.123
High school diploma	0.399
Associate degree	0.094
Some college	0.205
Bachelor's degree	0.179
Technical occupation	0.227
Other control variables	
Age between 21 and 25	0.162
Age between 26 and 30	0.252
Age betwen 31 and 35	0.296
Age between 36 and 40	0.290
Resides in South	0.296
Resides in Northeast	0.220
Government employee	0.108
1997	0.490
Sample size	17,076

Results—Earnings premium for postsecondary education and technical occupations

We estimate the premiums within each educational attainment grouping for the use of technical skills. The premium represents the earnings of people in a skill group compared to high school graduates employed in nontechnical occupations. Table 3 presents the regression results.

Figure 2 shows the estimated marginal effects of skills on earnings. Within every educational grouping, workers in technical occupations have significantly higher wages than workers not using technical skills. The premium for technical workers ranges from 12 percent for workers with A.S. degrees to 25 percent for workers with B.A.'s. All workers with postsecondary education, whether or not they have technical skills, earn significantly higher pay than high school graduates. And, the differentials increase as skill levels increase—from a low of 9 percent for nontechnical workers with some college to a high of 62 percent for technical workers with B.A.'s.

The premium to technical workers with Associate degrees (the skill mix we expect the Navy to require for the new high-tech jobs) averages 25 percent. Based on average earnings of $28,500 for nontechnical Caucasian men with high school diplomas, the private-sector differential equals about $7,250 more annually.[9] The range of differentials, based on the 95-percent confidence interval, is from 18 to 27 percent. For existing high-tech occupations that change from requiring a high school education to one requiring an Associate degree, the increase is less—about 12 percent—with the vast majority of such jobs paying between 8 and 16 percent more.

9. Because we use 1997 data, all earnings estimates in this paper are presented in 1997 dollars. Current 1999 earnings would be about 5 percent higher.

Table 3. Earnings premium for postsecondary education and technical skills[a]

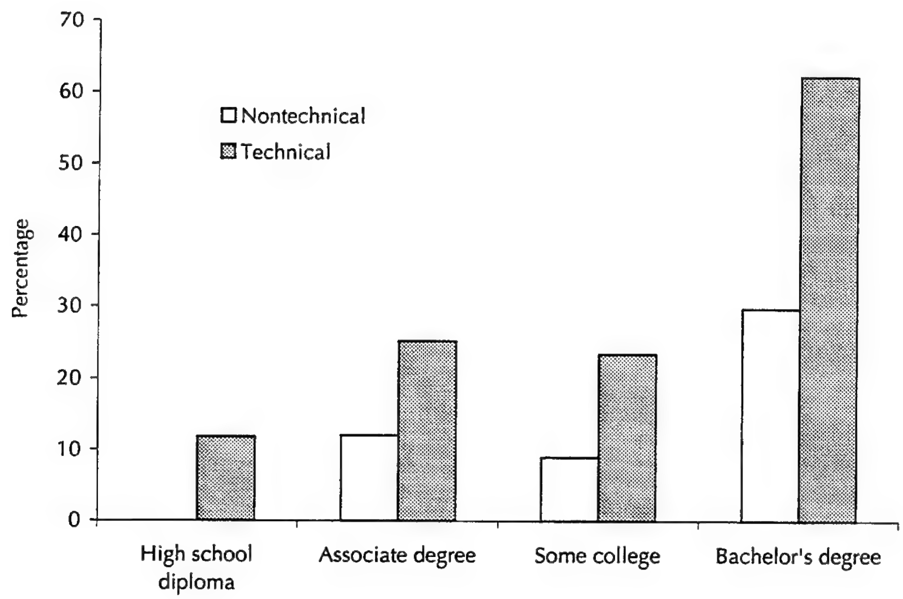
Variable	Coefficient estimate[b,c] (std. error)
Technical, no high school diploma	-0.151* (0.029)
Nontechnical, no high school diploma	-0.261* (0.011)
Technical, high school diploma	.0112* (0.013)
Technical, Associate degree	0.225* (0.018)
Nontechnical, Associate degree	0.114* (0.015)
Technical, some college	0.210* (0.016)
Nontechnical, some college	0.086* (0.010)
Technical, Bachelor's degree	0.483* (0.015)
Nontechnical, Bachelor's degree	0.260* (0.011)
Resides in South	-0.024* (0.008)
Resides in Northeast	0.058* (0.008)
Government employee	0.024* (0.011)
Age between 26 and 30	0.222* (0.010)
Age between 31 and 35	0.345* (0.010)
Age between 36 and 40	0.448* (0.010)
1997	0.026* (0.007)
Constant	9.820 (0.010)
Adjusted R-squared	0.245
Sample size	17,076

a. Dependent variable is log(annual earnings).

b. The percentage change in earnings for a change in a dichotomous variable equals exp(*b*) - 1, where *b* is the coefficient estimate.

c. * Denotes statistical significance at a 99-percent confidence level.

Figure 2. Earnings premiums relative to nontechnical high school graduates



We also find large, in fact, even larger, premiums for women and minority men. Complete regression results for both groups are in appendix A, as well as earnings premiums for different age groups. The important empirical findings follow:[10]

- The earnings premium for women with Associate degrees and technical skills is 38 percent. Based on average annual earnings of $20,750 for nontechnical women with high school diplomas, this differential would equal about $7,750 annually.

- The earnings premium for minority men with Associate degrees and technical skills is 51 percent. Based on the average annual earnings of $24,250 for nontechnical minority men with high school degrees, this differential would equal about $12,250 annually.

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10. Earnings in the private sector may vary between demographic groups for many reasons, including differences in overall work experience, skills acquired, occupations entered, and discrimination.

- Earnings premiums for Associate degrees and technical skills of 19 to 35 percent exist across age groups. Earnings premiums for all other categories of postsecondary schooling also exist for workers of all age groups.

To compete with the private sector, the Navy will have to pay the high-tech recruits similar premiums. Although the premiums for specific new Navy occupations should generally fall in the estimated ranges, demand and supply conditions for certain occupational skills may mean that required compensation, in some ratings, will fall outside the estimated ranges. But, without using occupational detail, these estimates should serve as a general guide for the Navy in estimating compensation increases for new occupations.

Earnings for specific occupations

Our objective in this section is to estimate the earnings differentials the Navy might expect for selected high-tech occupations. The occupations we analyze are not the only new occupations likely to emerge; other occupations in fields as diverse as food services or flight control may also materialize. But, we selected these occupations because they represent a spectrum of new occupations and platforms and because there is less uncertainty about their existence on future platforms. The occupations we focus on are:

- Command and Control Technician—on surface combatants
- Material Scheduler/Planner—on carriers and CLF ships
- Network Administrator—Navy-wide.

Driven by the new technologies, these three occupations will effectively replace some or all of the combat systems ratings, some supply ratings and Gendets, and a segment of radiomen/data processing jobs,[11] respectively. These existing ratings represent skilled and semi-skilled repairers and operators, general physical laborers, shopkeepers, and computer technicians. Consequently, our comparisons highlight the differences in compensation for different skill requirement changes.

We first describe the tasks of the sailors in these new occupations and identify occupations in the private sector similar to the current and future Navy jobs. Then, we estimate the differences in compensation before and after technology adoption for each new occupation separately, accounting for differences in the characteristics of the workers. We again rely on private-sector compensation information to estimate the individual occupational earnings differentials.

11. The data processing rating (DP) merged with radioman (RM) in 1998.

Description of occupations

Based on Navy documents and conversations with Navy personnel, we describe here the projected job requirements for sailors in each of the three sample occupations. Of course, the designs of the platforms are not final and the job requirements are subject to change.

Command and Control Technician

The new technologies are expected to transform today's Combat Information Center (CIC).[12] Continued automation of sensing and tracking functions will eliminate many of the functions of some sailors, while requiring more in-depth analysis of systems' outputs and decision-making. Sailors within combat systems on surface combatants will:

- Operate, monitor, and modify computer systems and devices that acquire or analyze tactical data
- Use theoretical knowledge to provide context and to recommend and implement action
- Use technical knowledge to assist in evaluating systems hardware failures.

Matching the tasks to established private-sector occupations,[13] we anticipate that the skill requirements will include:

- Postsecondary schooling of at least 2 years in a technical field, such as engineering, physics, or mathematics
- Computer proficiency
- Written and oral communication skills.

The new job will replace some of the existing ratings within combat systems on surface combatants.[14] Because many of the existing rat-

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12. See [1] for further details on the Navy's adoption of new technologies.
13. We used the U.S. Department of Labor's Dictionary of Occupational Titles which we describe in detail in the next section.
14. Ratings that may be affected include DS, EW, FC, GM, OS, and STG.

ings are already high-tech and require extensive formal Navy training in electronics and repair, we anticipate that the compensation difference will be relatively small.

Material Scheduler/Planner

Automation of distribution functions on carriers will emulate just-in-time inventory systems of private-sector manufacturing plants. Much of the physical labor required currently will be eliminated, shifting the emphasis to delivery and inventory management. The sailors' responsibilities will include:

- Using computer forecasting tools to develop and analyze lists of parts, equipment, and materials to purchase
- Scheduling deliveries based on ship's storage capacity and handling facilities, and monitoring deliveries and resolving problems
- Tracking and improving the efficiency of delivery systems.

The skill requirements will include:

- Postsecondary schooling of at least 2 years in logistics, industrial engineering, materials management, or business
- Computer proficiency
- Written and oral communication skills.

With the new technologies, some supply jobs, such as storekeeper (SK) and ship's serviceman (SH), will largely disappear. Many Gendets involved in physical replenishment functions will also no longer be required. These existing ratings generally involve relatively little formal training and are nontechnical in nature. Based on the earlier analysis, we anticipate the compensation difference to be large.

Network Administrator

The new platforms are expected to incorporate ship-wide computer systems that will require network administrators to maintain. We expect their tasks to be very similar to those in the private sector—although the scope of functions may include other computer

maintenance functions that are sometimes categorized as other computer-related occupations. The sailors will:

- Evaluate the workload and capacity of the computer systems and make recommendations for improvements
- Evaluate and test software and systems for compatibility and potential failures
- Investigate and resolve data communication, software, and other problems within the system
- Provide assistance to individual users as needed.

The skill requirements include:

- Postsecondary schooling of at least 2 years in information technologies or equivalent certificates or awards
- Demonstrated computer network skills.

The new job will replace the data processing and data transmission tasks of the RM rating. Because the tasks being replaced are high-tech, the earnings differentials should be relatively small, based on our estimates in the previous section.

Estimating the earnings differentials

Statistical methodology and data

We use the same general estimation techniques and private sector data as in the previous section to avoid the difficulties inherent with private sector and military earnings comparisons.[15] Here, however, we estimate three separate regressions to compare each new occupation separately to the occupation it replaces.

As in the previous section, we select all full-time, nonagricultural workers between the ages of 21 and 40 from the CPS for our analysis.

15. Private-sector and military earnings should not be compared directly. The benefit/pay mixes differ between the two, so differences in pay do not accurately reflect the differences in total compensation.

Again, we exclude workers with graduate degrees and people with full-time yearly earnings that were implausibly low or high. Because within-occupation differences in earnings' determination among demographic groups are relatively small, we include females and minorities in this sample. To control for remaining differences among the workers, we include the following explanatory variables:

- Years of work experience (as proxied by age)
- Region of the country in which the worker resides
- Whether the worker is a goverment employee
- Race of the worker
- Gender of the worker.

Matching Navy occupations to private-sector occupations

To estimate the compensation differentials, we must first select the private-sector occupations to compare. Matching the new Navy occupations to the CPS occupations requires two cross-walks. The first step is to match the job descriptions we developed to detailed private-sector occupations. The second step is to map the detailed occupations into the CPS occupational groupings. The Navy has already done the first step for current Navy occupations; therefore, only the second step is necessary for those.

To match the new occupations' tasks with private-sector occupations, we use the Department of Labor's Dictionary of Occupational Titles (DOT). The DOT provides descriptive information on over 12,000 occupations. Each occupational description includes the primary tasks of the occupation, the education and training requirements, and the level of mathematical, language, and reasoning skills required, as well as the complexity of interaction required with data, people, and equipment. The detailed occupations are aggregated into small, homogeneous groups, and then categorized into ever larger groupings.

In our matching, we found that individual Navy occupations may correspond to several private-sector occupations. Indeed, any individual occupation may have seemingly disparate private-sector occupations

matched to it because the private-sector occupations are tied to different aspects of the Navy occupation. For example, the command and control technician uses the same engineering skills as an electronics technician, but the same analytical skills as a nuclear power plant operator. We present our final crosswalk from Navy occupations to private-sector equivalent occupations in the first two columns in table 4.

Table 4. Crosswalk between Navy occupations and private-sector counterparts

Navy occupation	DOT Counterparts	CPS Occupational Groupings
Command and Control Technician	Electronics Technician Flight-Test Data Acquisition Technician Instrumentation Technician Nuclear Power Plant Operator	Electrical and Electronics Technician Power Plant Operator
Combat systems ratings	Electronics Tester Electronics Mechanic/Technician Computer Operator Computer Peripheral Operator Communications Technician Radio-Intelligence Operator	Computer Operator Peripheral Equipment Operator Electronic Repairers Data Processing Equipment Repairers Broadcast Equipment Operators Chief Communications Operator
Material Planner	Material Scheduler Production Planner Industrial Engineering Technician	Industrial Engineering Technician Supervisor, Distribution/Scheduling Clerks Production Coordinators
Supply ratings and Gendets	Stock Control Clerk and Supervisor Accounting Clerk Shipping and Procurement Clerk Warehousing and Hoisting Laborers Material Handlers, Material Equipment Operators Sailors and Deckhands Stevedore	Bookkeepers, Accounting, and Auditing Clerks Traffic, Shipping And Receiving Clerks Stock and Inventory Clerks Material Scheduling, Distribution Clerks Sailors and Deckhands Material Moving Equipment Operators Freight, Stock, and Material Handlers
Network Administrator	Microcomputer Technical Support Network Control Operator Computer Systems Hardware Analyst	Programmers
Data processing ratings	Computer Operator Computer Peripherals Operator	Computer Operator Peripheral Equipment Operator

From the detailed occupations, we aggregate the occupations into broader occupational groupings, in order to match the Current Population Survey. As a result, our analysis includes a greater dispersion of skills than the DOT crosswalk. The final column in table 4 shows the mapping of the Navy occupations into CPS occupations.

As a check on how well the Navy occupations and private sector occupations match, we compare whether differences between the Navy pay in existing ratings and pay in the private sector are consistent. The Navy earnings include basic pay, proficiency pays, and housing allowances.[16] In table 5, we compare the average actual Navy earnings for all enlisted sailors in the affected ratings to the earnings in the equivalent private sector occupations. In all three cases, average Navy earnings are less than the private-sector earnings. Because Navy benefits are typically more generous than those in the private sector, this is reasonable.

Table 5. Earnings comparison of Navy and private-sector equivalents

Occupations	Navy[a]	CPS[b]
Combat systems	26,542	30,007
Supply and Gendets	18,969	21,482
Data processors	24,325	26,325

a. Navy earnings calculated using 1996 JUMPS mean earnings for the specified ratings groups.

b. Private-sector equivalent earnings calculated using the mean earnings in the Navy equivalent CPS occupational group.

The differentials are generally consistent with other research [13], although the private-sector earnings for jobs equivalent to combat systems jobs appears somewhat high. The reason this occurs involves the

16. Because we want to compare the occupational pay within the Navy to private-sector earnings, we exclude special pays that are paid because of the hardships particular to Navy assignments (e.g., sea pay, hazardous duty pay).

occupations in combat systems. Combat systems, which includes skilled operators and repairers, also employs many sailors in radio-control tasks—jobs that represent the lower paying jobs in combat systems. Relatively few private-sector workers, however, are employed in equivalent jobs. The differential we estimate is then best interpreted as the premium compared to combat systems repairers and operators of complex electronic equipment (excludes some radiomen and operation specialists).

Given our definitions, table 6 presents sample means for the relevant characteristics for each occupation (using the private-sector data). Not controlling for differences between worker characteristics, workers in jobs equivalent to the new Navy occupations earn substantially more than workers in jobs similar to current Navy occupations. The new high-tech occupations are also more likely, in the private sector, to be filled by nonminority men. Finally, workers in the new occupations have more work experience than workers in the current jobs; less than 33 percent of workers in new occupations are under 30 years of age versus more than 45 percent of workers in current jobs.

Table 6. Sample means for the specific occupational samples

	Command and Control Technicians		Material Planners		Network Administrators	
Variables	Future	Current	Future	Current	Future	Current
Earnings	36,387	30,007	30,808	21,482	35,159	26,325
Male	0.903	0.660	0.531	0.482	0.765	0.409
Black	0.065	0.110	0.094	0.111	0.030	0.134
Hispanic	0.104	0.113	0.133	0.143	0.076	0.141
Resides in South	0.325	0.317	0.344	0.355	0.311	0.362
Resides in Northeast	0.214	0.257	0.141	0.199	0.250	0.289
Age between 26 and 30	0.188	0.240	0.195	0.252	0.235	0.262
Age between 31 and 35	0.325	0.300	0.281	0.258	0.348	0.289
Age between 36 and 40	0.396	0.277	0.406	0.257	0.273	0.268
Government employee	0.143	0.137	0.133	0.062	0.144	0.121
Sample size	154	300	128	1,124	132	149

Results

We present the regression estimates for all three occupational changes in table 7. Each earnings differential represents the difference in earnings between occupations equivalent to the future Navy job and occupations similar to the jobs being replaced. Figure 3 shows the marginal effects.

Workers in each of the new occupations earn significantly more than workers in jobs being replaced. Consistent with the skill-earnings estimates in the previous section, the highest differential occurs for the high-tech occupation that replaces the occupations with the least formal training—the Material Scheduler with a differential of 34 percent, or about $7,250 in pay above supply occupations annually.[17]

The lowest differential we estimate (13 percent) applies to the Command and Control Technician, which replaces high-tech jobs requiring a mix of formal training. The differential translates into annual earnings about $4,000 higher than in current occupations. This estimate may underestimate the true earnings differential the Navy might expect to pay should all combat systems jobs disappear. For reasons explained earlier, the estimated differential best reflects the earnings the Command and Control Technician would earn as compared to the more highly trained repairers or operators within combat systems currently.

17. If compensation in the existing Navy occupations is not competitive with the private sector now, the Navy will also not be competitive in the new occupations. Applying these differentials directly to current earnings that are too low to retain the sailors needed implies compensation too low to recruit and retain sailors with the skills the Navy will need in the future.

Table 7. Determinants of annual earnings by occupation[a]

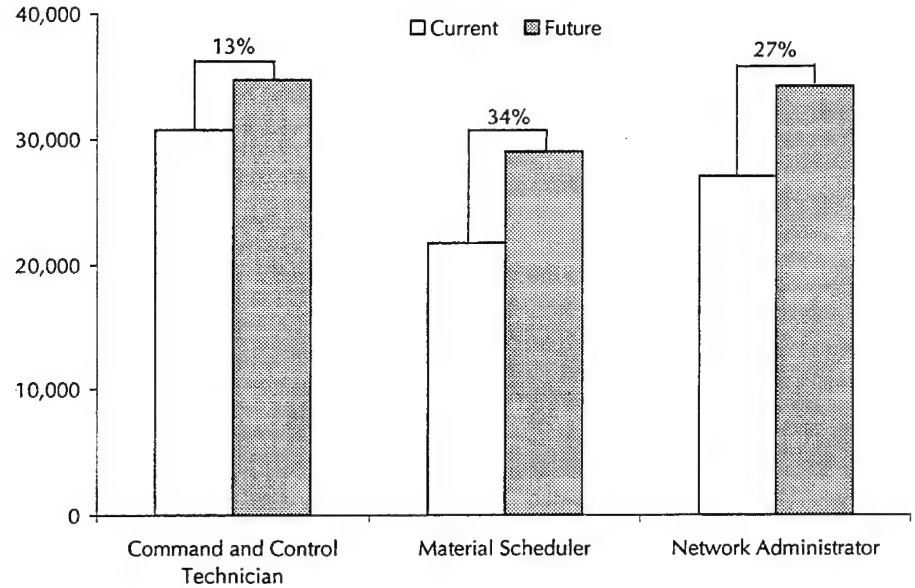
Variables	Command and Control Tech.[b,c] (std. error)	Material Planner[b,c] (std. error)	Network Administrator[b,c] (std. error)
New occupation	0.119* (0.042)	0.292* (0.032)	0.237* (0.050)
Age between 26 and 30	0.165* (0.063)	0.182* (0.028)	0.327* (0.073)
Age between 31 and 35	0.274* (0.060)	0.211* (0.028)	0.417* (0.070)
Age between 36 and 40	0.354* (0.061)	0.357* (0.028)	0.479* (0.072)
Government employee	0.013 (0.056)	0.125* (0.038)	-0.098 (0.069)
Male	0.196* (0.045)	0.142* (0.020)	0.151* (0.049)
Black	-0.029 (0.065)	-0.042 (0.032)	0.063 (0.085)
Other minority	-0.070 (0.061)	0.011 (0.028)	-0.009 (0.074)
Resides in South	-0.016 (0.045)	-0.050** (0.022)	-0.022 (0.054)
Resides in Northeast	0.059 (0.048)	0.052** (0.026)	0.074 (0.059)
Earnings from 1997	0.065*** (0.038)	0.029 (0.019)	0.054 (0.046)
Constant	9.835* (0.065)	9.636* (0.028)	9.658* (0.075)
Adjusted R-squared	0.164	0.223	0.262
Sample size	454	1,252	281

a. Dependent variable is log(annual earnings).

b. The percentage change in earnings for a change in a dichotomous variable equals exp(*b*) - 1, where *b* is the coefficient estimate.

c. * Denotes statistical significance at a 99-percent confidence level.
** Denotes statistical significance at a 95-percent confidence level.
*** Denotes statistical significance at a 90-percent confidence level.

Figure 3. Earnings differentials (%) for specific occupations based on annual earnings ($)



Finally, we estimate that Network Administrators in the Navy should earn about 27 percent more, or about $7,250 more annually, than existing computer personnel for the Navy to be competitive with the private sector. The broad compensation analysis would have predicted a premium of about 13 percent.

Why is this estimate so much higher? It is because the specific occupational skills are so highly valued. The Network Administrator highlights the occupational variation in earnings due to private-sector supply and demand for specific occupational skills—occupational variation that the broad compensation estimates will not reflect. The Department of Labor's Occupational Handbook cites Network Administrators as one of the top ten growth occupations. The demand for Network Administrators and Computer Technicians has increased dramatically as computer equipment prices have fallen and new computer technologies have emerged. The supply of computer specialists has not increased as quickly as demand, and the demand pressures have driven the wages up—higher than our first analyses would indicate.

We are confident that our estimates, in both the specific occupational estimation and the broad skill-earnings estimation, are reasonable.

Implications and recommendations

In this research memorandum, we discussed the compensation differentials the Navy might expect to pay for a new category of sailors. We compared estimated earnings differentials of those with the general skills the Navy expects to require and workers with the skills of today's sailors. These differentials reflect the average increases across all new occupations the Navy might experience. Then, we showed the estimated differentials in selected occupations—illustrating the effects of specific occupational demand and supply conditions.

We summarize the important empirical findings as follows:

- Based on our broad compensation estimation, sailors in new occupations requiring an Associate degree may require an earnings premium of about 12 percent over the current occupation.
- Among those holding Associate degrees, the Navy will have to pay sailors using technical skills about 13 percent more than those not using technical skills.
- The highest premiums will occur in occupations that replace occupations requiring little training. The Navy can expect to pay on average about 25 percent more for sailors with Associate degrees and technical skills relative to high school graduates in nontechnical occupations. If new Navy occupations require more than a 2-year degree, differentials for jobs before and after technology adoption may rise to 60 percent or more.
- Demand for and supply of specific skills in the private sector may mean higher or lower differentials in some occupations. The Network Administrator with an estimated 27-percent premium is an example of the former.

Of course, the differentials the Navy will experience 20 to 30 years into the future may be different from what we have estimated. We estimate current differences in earnings and project the same differences into

the future. Wage pressures may change, however, and our estimates may either overstate or understate future pay differentials. Differentials could grow in the short run if demand for high-tech skills outstrips supply. In the long run, a large influx of students into the high-paying occupations would drive down overall compensation in the occupation. But, even if the differentials shift somewhat, we expect premiums for these jobs in the future because the skills in these occupations require substantial formal training to learn. The earnings we have estimated should provide the Navy with the best guidance now available for estimating future manpower costs.

Implications for the Navy

Navy recruiting and retention

The compensation that the Navy offers for the new high-tech occupations will partly determine the success it will have in recruiting and retaining people with the right skills. The Navy must determine its recruiting and retention strategy with that in mind. If it pays noncompetitively, the Navy may have difficulty recruiting and retaining high-quality individuals. Because we do find substantial numbers of people being trained in the right skills, the Navy should be able to attract people with the right skills if it can solve its compensation problem.[18]

Ship manpower costs

It is evident, given the results of this analysis, that ship cost calculations using current average pay understate personnel costs.

How large are the underestimates? It, of course, depends on the proportion of new high-tech jobs and the size of the compensation differential. Exact manpower requirement counts are not available this early in the process of platform planning and design. Therefore, we estimate broad ranges for manpower costs for two new platforms, the DD-21 and the CVX. These calculations are for illustrative purposes;

18. For more information on the number of people trained in the appropriate skills, see appendix B.

the skill mix and manning reduction we assume may not reflect the final platform designs.

Among the new platforms, DD-21, the new surface combatant, is expected to have the largest reductions in manpower. The program has been tasked to:

- Man the ships at 30 percent the manning of the DDG-51 class,
- Reduce Operating and Support (O&S) costs to 30 percent of the DDG-51 class.

To achieve these goals, program managers anticipate needing a highly trained and educated crew, and they have constructed a notional paygrade mix based on that expectation [14]. The exact crew mix is unknown at this time, so we use a range of assumptions, i.e., that somewhere between 25 and 75 percent of the crew work in the new occupations.

In table 8, we show estimated costs for a traditional destroyer, the DD-21 using the average annual enlisted programming rate, and the DD-21 incorporating a 15- to 30-percent differential for 25, 50, and 75 percent of a nominal enlisted crew of 150. The average programming rate is $38,000. In either case, the program saves substantial manpower costs, but the new premium does increase manpower costs by 4 to 23 percent over estimates using average manpower rates for DD-21.

Table 8. Annual manpower costs for surface combatants (in millions of dollars)

Platform and approximate enlisted crew size	Earnings differential				
	0%	15%	20%	25%	30%
Traditional destroyer manning = 300	11.4				
New destroyer manning = 150	5.7				
New destroyer manning = 150 with:					
25% high-tech sailors		5.9	6.0	6.1	6.1
50% high-tech sailors		6.1	6.3	6.4	6.6
75% high-tech sailors		6.3	6.6	6.8	7.0

For the new carrier CVX, the program goal is to reduce manpower and manpower costs—attaining a 30- to 50-percent reduction in manning for the final carrier. Table 9 shows estimated costs for a 20-percent reduction in manning. Because the platform planning is in preliminary stages and no estimates of sailor mix exist, we again apply a range of assumptions. The costs are again underestimated by 4 to 23 percent.

Table 9. Annual manpower costs for a carrier (in millions of dollars)

Platform and approximate enlisted crew size	Earnings differential				
	0%	15%	20%	25%	30%
Traditional carrier manning = 3,100	117.8				
New carrier manning = 2,480	94.2				
New carrier manning = 2,480 with:					
25% high-tech sailors		97.8	99.0	100.1	101.3
50% high-tech sailors		101.3	103.7	106.0	108.4
75% high-tech sailors		104.8	108.4	111.9	115.4

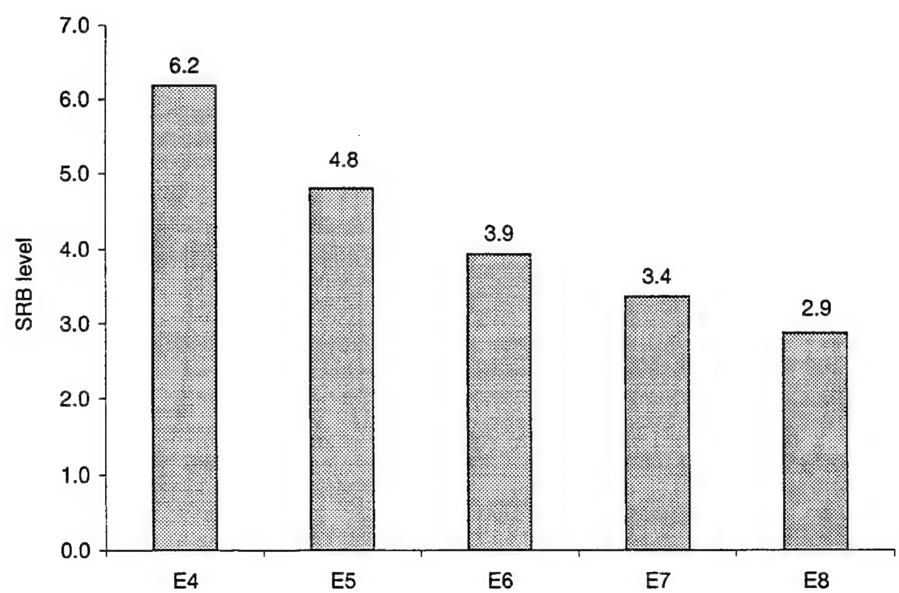
Implications for the compensation system

Given that sailors of the future may require compensation substantially higher than today's sailors—with some differentials reaching over 30 percent more than the occupations they replace—the Navy must determine whether the current compensation system can accommodate such large differentials. To answer this question, we apply the tools the Navy currently has available to compensate skills to one of the occupations we analyzed earlier. The primary compensation tools are faster advancement (basic pay and other pays are tied to rank), Selected Reenlistment Bonuses (SRBs), and Enlistment Bonuses (EBs). To check whether the entire range of occupational premiums can be accommodated, we focus on the occupation that requires the highest compensation—the Network Administrators. The differential is 27 percent or, annually, about $7,250 more in pay than existing computer and data communications ratings, and, because they replace high-tech jobs, the base from which the differential is calculated

($24,325 annual compensation) is slightly higher than the average sailor's compensation.

We show, in figure 4, the SRB levels required to provide the $7,250 premium to the Network Administrator for the following 4 years, given their paygrade at reenlistment. We assume the premium is constant across the career of the sailor.[19] Total SRB payments for Network Administrators would stay below current legal maximums ($45,000 for an enlistment or 10 levels), but would be much higher than current practice. Unlike the general use of SRBs now in which certain, usually first, reenlistment points are targeted, SRBs would have to be paid at every reenlistment point. Should any differential require more than the maximum levels, increases in limits must be approved through the Unified Legislative and Budgeting (ULB) process and require legislative approval.

Figure 4. Average SRB levels required for Network Administrators by paygrade at reenlistment



19. We use JUMPS basic pay data for DPs and RMs in calculating the SRB levels.

Of course, SRBs do not compensate the sailor during the first enlistment period, so EBs would also be required. The new EB maximum being sought is $20,000 and, even then, is lower than the Navy would need for the high-tech sailor. The Navy would have to seek higher maximum EB payments through the ULB to create a competitive compensation package.

Theoretically, the current SRB system could support the differentials while the EB would have to be increased. In practice, though, such high bonuses have never been paid across a rating and large variations in average compensation across ratings have been limited. Excluding Gendets, the largest difference in pay (including base pay, housing and proficiency pays) is about $5,250. With the advent of the new high-tech sailor and the continued need for sailors with less training, the variation between ratings will widen to about $12,000. The variation is significantly outside the range of current differentials. This will pose a challenge to the Navy. Not only may the compensation system not be flexible enough, but the greater pay variation also breaks with traditional Navy culture, which maintains the importance of equal pay for sailors working side by side on ships.

In addition, the current system may not be the most efficient means of paying for skills. Why is that?

- Faster advancement for some means slower advancement, lower earnings, and lower retention for others—unless SRBs are also used for the ratings affected adversely.
- Command authority is tied to rank, but, because the Navy would use faster advancement solely for pay purposes, the Navy would have to sever the two, or at least change the way the two are linked.
- The new compensation packages will require heavy reliance on bonuses—with perhaps 25 percent of pay in bonuses. But, such large bonuses are not typical in the private sector for these occupations, and they may be perceived as less attractive than basic pay. In addition, SRB accounts have been underfunded in the past. Sailors may require additional compensation to accept such a package.

- Special pays linked to basic pay (e.g., retirement pay) will be relatively too low for the high-tech sailor and may no longer be competitive. The Navy would have to introduce special pays for retirement, or link retirement to full pay.

Recommendations

We find that the Navy should expect to pay premiums for high-tech, formally trained sailors—premiums that could affect recruiting, retention, manpower budgeting, and the compensation system. Based on our findings, we recommend that the Navy:

- Incorporate the higher costs for new sailors into the planning and budgeting process.
- Set compensation rates for high-tech sailors, taking into account the fact that the Navy will compete with the private sector for new recruits. Compensation set too low will make recruiting and retention of highly qualified people difficult.
- Study the advantages of alternative compensation structures that might achieve the goals of the military more efficiently, such as:
  - Skill-based pay systems that are tied to educational attainment and skills (including skill-based pays in which command authority is one dimension of pay). Such skill-based pay systems would involve a system of several skill levels in which a sailor could remain in a skill level for an entire career, progressing to higher paygrades within the skill level, or move to higher skill levels and pay.[20]
  - Identifying changes within the current system that allow it to function as a skill-based pay system (e.g., the expansion of warrant officer classification or shadow premiums, an Army initiative, for high-tech sailors).
- Continue tracking earnings in the private sector and changes in the supply and demand conditions for new occupational skills.

20. See [1] for further details on how a skill-based pay system might be adapted to the Navy.

Appendix A: Additional summary statistics and regression results

Table 10. Summary statistics for other samples

Variable	All women		Minority men	
	Means	Standard deviation	Means	Standard deviation
Annual earnings	23,211	12,055	26,404	14,380
Primary independent variables				
High school dropout	0.065	0.247	0.128	0.334
High school diploma	0.356	0.489	0.409	0.492
Associate degree	0.122	0.327	0.079	0.270
Some college	0.229	0.420	0.224	0.417
Bachelor's degree	0.229	0.420	0.160	0.336
Technical skills	0.102	0.303	0.177	0.382
Other control variables				
Age between 21 and 25	0.168	0.374	0.152	0.359
Age between 26 and 30	0.260	0.439	0.256	0.437
Age betwen 31 and 35	0.281	0.449	0.292	0.455
Age between 36 and 40	0.291	0.454	0.300	0.458
Resides in South	0.334	0.472	0.442	0.497
Resides in Northeast	0.225	0.417	0.206	0.404
Government employee	0.155	0.362	0.163	0.404
1997	0.478	0.500	0.455	0.498
Caucasian	0.883	0.382		
Sample size	12,895		2,486	

Table 11. Earnings premium for postsecondary education and technical skills[a]

Variable	Coefficient estimate[b,c] (std. error)	
	All women	Minority men
Constant	9.585*	9.781*
	(0.014)	(0.029)
Age between 26 and 30	0.148*	0.131*
	(0.011)	(0.028)
Age between 31 and 35	0.220*	0.229*
	(0.011)	(0.028)
Age between 36 and 40	0.258*	0.265*
	(0.011)	(0.028)
1997	0.038*	0.049*
	(0.007)	(0.018)
Technical, no high school diploma	0.085	0.081
	(0.075)	(0.098)0
Nontechnical, no high school diploma	-0.174*	-0.123*
	(0.015)	(0.029)
Technical, high school diploma	0.206*	0.247*
	(0.023)	(0.042)
Technical, Associate degree	0.320*	0.412*
	(0.024)	(0.058)
Nontechnical, Associate degree	0.196*	0.176*
	(0.012)	(0.040)
Technical, some college	0.238*	0.316*
	(0.023)	(0.046)
Nontechnical, some college	0.114*	0.130*
	(0.010)	(0.025)
Technical, Bachelor's degree	0.620*	0.549*
	(0.020)	(0.040)
Nontechnical, Bachelor's degree	0.382*	0.250*
	(0.020)	(0.031)
Resides in South	-0.011	-0.071*
	(0.008)	(0.020)
Resides in Northeast	0.096*	0.020
	(0.009)	(0.024)
Government employee	0.034*	0.114*
	(0.010)	(0.024)
Caucasian	0.030*	
	(0.009)	
Adjusted R-squared	0.227	0.197
Sample size	12,895	2,486

a. Dependent variable is log(annual earnings).

b. The percentage change in earnings for a change in a dichotomous variable equals exp(*b*) - 1, where *b* is the coefficient estimate.

c. * Denotes statistical significance at a 99-percent confidence level.

Table 12. Earnings premium for postsecondary education and technical skills by age[a]

Variable	Coefficient estimate for Caucasian men[b,c] (std. error)
Constant	9.850* (0.014)
Age between 26 and 30	0.215* (0.018)
Age between 31 and 35	0.293* (0.017)
Age between 36 and 40	0.405* (0.017)
1997	0.026* (0.007)
Technical, no high school diploma	
Age between 21 and 26	0.019 (0.08)
Age between 26 and 30	-0.157* (0.060)
Age between 31 and 35	-0.143* (0.048)
Age between 36 and 40	-0.218* (0.053)
Nontechnical, no high school diploma	
Age between 21 and 26	-0.214* (0.025)
Age between 26 and 30	-0.277* (0.023)
Age between 31 and 35	-0.267* (0.021)
Age between 36 and 40	-0.281* (0.022)
Technical, high school diploma	
Age between 21 and 26	0.086** (0.035)
Age between 26 and 30	0.097* (0.028)
Age between 31 and 35	0.125* (0.024)
Age between 36 and 40	0.0129* (0.023)

Table 12. Earnings premium for postsecondary education and technical skills by age[a] (continued)

Variable	Coefficient estimate for Caucasian men[b,c] (std. error)
Technical, Associate degree	
Age between 21 and 26	0.197* (0.052)
Age between 26 and 30	0.175* (0.037)
Age between 31 and 35	0.285* (0.031)
Age between 36 and 40	0.217* (0.032)
Nontechnical, Associate degree	
Age between 21 and 26	0.063 (0.040)
Age between 26 and 30	0.056*** (0.029)
Age between 31 and 35	0.156* (0.026)
Age between 36 and 40	0.147* (0.027)
Technical, some college	
Age between 21 and 26	0.145* (0.041)
Age between 26 and 30	0.245* (0.033)
Age between 31 and 35	0.212* (0.029)
Age between 36 and 40	0.219* (0.028)
Nontechnical, some college	
Age between 21 and 26	-0.002 (0.023)
Age between 26 and 30	
Age between 31 and 35	0.069* (0.020)
Age between 36 and 40	0.118* (0.019)

Table 12. Earnings premium for postsecondary education and technical skills by age[a] (continued)

Variable	Coefficient estimate for Caucasian men[b,c] (std. error)
Technical, Bachelor's degree	
Age between 21 and 26	0.388* (0.046)
Age between 26 and 30	0.454* (0.028)
Age between 31 and 35	0.535* (0.026)
Age between 36 and 40	0.492* (0.027)
Nontechnical, Bachelor's degree	
Age between 21 and 26	0.156* (0.030)
Age between 26 and 30	0.180* (0.021)
Age between 31 and 35	0.321* (0.020)
Age between 36 and 40	0.322* (0.020)
Resides in South	-0.024* (0.008)
Resides in Northeast	0.056* (0.008)
Government employee	0.025** (0.011)
Adjusted R-squared	0.248
Sample size	17,076

a. Dependent variable is log(annual earnings).
b. The percentage change in earnings for a change in a dichotomous variable equals exp(*b*) - 1, where *b* is the coefficient estimate.
c. * Denotes statistical significance at a 99-percent confidence level.
** Denotes statistical significance at a 95-percent confidence level.
*** Denotes statistical significance at a 90-percent confidence level.

Appendix B: Workforce and degree completion statistics

Table 13. Availability of skilled individuals

	Workers with technical degrees or using technical skills	Command and Control Technician	Material Scheduler/ Planner	Network Administrator
Relevant fields of study[a]	Engineering-related Mechanics Precision production Science and science technologies Logistics Information technologies	Engineering-related Physics Mathematics	Logistics Transportation Industrial engineering Materials management	Information technologies
Annual Associate degrees awarded in relevant fields[b]	58,500	37,500	6,000	11,500
Workers in relevant occupations[c]	4,800,000	325,000	75,000	350,000

a. Information source: U.S. Department of Labor, Dictionary of Occupational Titles.
b. Information source: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, "Completions" survey, 1994-95 and "Consolidated" survey, 1995.
c. Information source: U.S. Department of Labor, National Occupational Employment and Wage Data, 1996.

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